Compliance Guideline for Meat and Poultry Jerky Produced by Small and Very Small Plants

Purpose

The purpose of this document is to provide small and very small meat and poultry plants with guidance material and updated information on the safe manufacture of jerky. It is not intended to set a regulatory requirement, only guidance material. This guideline includes measures that small and very small establishments that process jerky products can use to achieve adequate lethality. These measures are described in the applicable processing step below under "Lethality Compliance Guidelines for Jerky."

Background

Meat or poultry jerky is a ready-to-eat (RTE), dried product that is generally considered to be shelf-stable (i.e., it does not require refrigeration after proper processing). In the early fall of 2003, FSIS found that producers of meat and poultry jerky may not be adequately processing jerky to achieve the lethality necessary to produce a safe product. FSIS identified two points in jerky processing where producers may need to do a better job.

First, jerky may not be adequately heat treated to meet the lethality performance standards if the requirement for moist cooking is not achieved. Some processors use dry heat to both heat and dry their product and, thus, do not achieve adequate lethality during the heating process because the product dries prematurely, and the lethality process stops.

Secondly, FSIS became aware that some manufacturers rely upon the maximum moisture-protein-ratio (MPR), rather than water activity, for determining whether their process adequately dries the jerky to produce a shelf-stable product. While an MPR of 0.75:1 or less remains part of the standard of identity for jerky, water activity, as measured by laboratory analysis, should be used to verify that the jerky is properly dried. Water activity is a better measure of available water for microbial growth than MPR. Minimizing available water (e.g., achieving a water activity of 0.80 or less) is critical for controlling the growth of pathogens.

Lethality Compliance Guidelines for Jerky

In general, jerky processing includes slicing or forming the meat or poultry, marinating the strips, heating them, and then drying them. The purpose of the heating step is to apply a lethality treatment to kill or reduce the numbers of microorganisms so that the jerky is safe for human consumption. Drying the jerky stabilizes the final product and prevents the growth of toxigenic microorganisms such as *Staphylococcus aureus*. Some processors combine the heating and drying procedures into one step. However, it is

critical that the heating accompanied by adequate humidity precede the drying.

If the times and temperatures in the lethality compliance guidelines are used, it is critical that the humidity criteria be rigorously followed during the cooking/heating (lethality) steps.

The following are general or common processing steps used in jerky production. Although an establishment's process may not include all these steps, the **lethality treatment and drying are required to produce a safe product**. The intervention step may be required for those processes that do not achieve an adequate lethality. The steps listed as heating and drying are consecutive steps. Drying should closely follow heating. Heating is used to achieve lethality of harmful microorganisms and drying is used to stabilize the product

Step 1 - Strip preparation: Whole muscle is sliced or ground; ground product is formed into strips.(Some jerky is formed)

Step 2 – Marination: The strips are then marinated in a solution that often contains salt, sugar, and flavoring ingredients.

Step 3 - Interventions: Antimicrobial interventions before and after marinating the strips of raw product have been shown to increase the level of pathogen reduction above that achieved by heating alone. Some processes may not deliver an adequate lethality and, therefore, may require an additional intervention step to ensure product safety. Examples of such interventions are:

- Preheating the meat or poultry jerky strips in the marinade to achieve a minimum internal temperature of 160°F will provide an immediate reduction of *Salmonella* (Harrison and Harrison, 1996). Because heating in the marinade may produce an unacceptable flavor for some products, other liquids, such as water, could be used. The times and temperatures in the lethality compliance guidelines could be used for preheating in the liquid.

- Dipping the product in 5 % acetic acid for 10 minutes before placing it in the marinade can augment the log reduction effects of drying but not enough to eliminate pathogens (Calicioglu, 2002 & 2003). This intervention may also result in an undesirable flavor.

Step 4 - Lethality treatment: The establishment must apply a treatment to control, reduce, or eliminate the biological hazards identified in the hazard analysis. For meat and poultry jerky, these hazards will most likely include the microbiological hazards from *Salmonella* spp., *Listeria monocytogenes*, and *Staphylococcus aureus*. For beef jerky, *Escherichia coli* O157:H7 may also be a hazard reasonably likely to occur. In recent years, several jerky products have been found to be adulterated with *Salmonella* and *E. coli* O157:H7.

For meat jerky, use of the time-temperature combinations provided in the lethality compliance guidelines should help to ensure the safety of the product. These time-temperature combinations are based on experiments that were done with ground beef without added salt or sugar. Added salt, sugar, or other substances that reduce water activity will increase the heat resistance of bacteria in a product. However, time and experience have shown that the time-temperature combinations in the lethality compliance guidelines have been sufficient to produce safe products even with both salt and sugar additives but the **humidity during heating is a critical factor**.

For poultry jerky, to produce a safe product, producers can use the minimum internal temperatures listed in the lethality compliance guidelines of 160°F for uncured poultry or 155°F for cured poultry. They can also use the time-temperature combinations listed in the poultry time-temperature tables of the Draft Compliance Guidelines for Ready-To-Eat Meat and Poultry Products that are posted on the FSIS website (www.fsis.usda.gov/OPPDE/rdad/FRPubs/Docs_97-013P.htm). However, **humidity during heating is a critical factor** regardless of which compliance guideline is used. As with meat jerky, the time-temperature combinations would be sufficient to produce safe products with both salt and sugar additives if the processor uses the humidity parameters applicable to beef as described below.

Therefore, for both meat and poultry, the humidity parameters described for meat products must be followed if the lethality compliance guidelines are used as supporting documentation. The time-temperature tables are based on wet-heat. Without humidity the product will dry, and the bacteria will become more heat resistant (Goepfert, 1970; Goodfellow and Brown, 1978; Faith, N.G. et al. 1998). As long as proper humidity is maintained, the level of pathogen reduction attained by using the lethality compliance guidelines for cooking poultry or whole beef should be sufficient to provide a safe product.

If the lethality compliance guidelines are used, the **relative humidity must be maintained above 90 percent throughout the cooking or thermal heating process** by using a sealed oven or steam injection. This level of humidity may not be necessary, however, if an establishment can provide documentation that its process can achieve an adequate lethality with less humidity. With adequate humidity, small mass products such as jerky should heat rapidly and attain the necessary time and temperature to meet the lethality compliance guidelines criteria for lethality. Therefore, because of this shorter heating time, FSIS is not incorporating the humidity criteria, “50 percent of the cooking time but in no case not less than one hour,” intended for large mass products into the compliance guidelines for jerky.

The heating temperature and humidity (e.g., steam) are critical for achieving adequate lethality. As the water activity is reduced, the heat resistance (D value) of the bacteria increases (Goepfert, 1970). Therefore, if adequate humidity is not maintained during

heating, the time at a particular temperature to eliminate *Salmonella* will be greatly increased. It is crucial that the processor prevent drying of the product until a lethal time-temperature combination is attained. The humidity requirement must be applied during the first part of the heating process before any drying and an increase in solute concentration occurs.

The process should be monitored using wet and dry bulb thermometers as noted below (values in Appendix A are wet bulb product temperature values). The use of wet and dry bulb measurements can be used to determine relative humidity (http://members.nuvox.net/~on.jwclymer/wet.html). For example, readings that show a difference of 2°F between the wet and dry bulbs might indicate approximately 94% relative humidity. Wet and dry bulb temperatures should not differ by more than 4.5°F. A temperature difference greater than 4.5°F indicates a relative humidity of approximately 86% and shows the needed minimum relative humidity (90%) is not being maintained.

At high altitudes, the amount of humidity in the chamber necessary to achieve a given log reduction of bacteria may need to be increased. Processing failures in the manufacture of jerky have occurred in establishments located at high altitudes.

Some simple and practical measures can be used to meet the humidity parameters in the lethality compliance guidelines:

- Seal the oven — Close the oven dampers to provide a closed system and prevent moisture loss. Steam may be observed venting when the dampers are closed, similar to venting that occurs in a steam retort during canning.
- Add humidity — Place a shallow and wide pan of hot water in the oven to provide humidity in the system. Conduct a test run to determine whether the water evaporates. Injecting steam or a fine water mist in the oven can also add humidity. Use of a wet bulb thermometer, in addition to the dry bulb thermometer, also would enable the operator to determine if adequate humidity is being applied.
- Monitor humidity — Use a wet bulb thermometer in combination with a dry bulb thermometer. A basic wet bulb thermometer can be prepared by fitting a wet, moisture-wicking cloth around a dry bulb thermometer. To maintain a wet cloth during the process, submerse an end of the cloth in a water supply. The cloth must remain wet during the entire cooking step and should be changed daily, especially if smoke is applied. The use of a wet bulb thermometer is especially important for production at high altitudes or areas of low humidity where evaporation is facilitated.

Step 5 – Drying: After the lethality treatment, the product should be dried to meet the

MPR product standard and to stabilize the finished product for food safety purposes. If the product is insufficiently dried, *S. aureus* and mold are potential hazards. These organisms are not expected to grow in properly dried products. A suggested water activity critical limit for stabilization of jerky is 0.80 or lower. This range of water activity should control growth of all bacterial pathogens of concern.

The establishment should verify the water activity to demonstrate that the product has attained the critical limit for shelf stability. Water activity is the key to determining the proper level of drying. The water activity can vary greatly at any given MPR (as a result of the presence and level of different solutes, such as sugar and salt). Therefore, a laboratory test for water activity should be used to verify proper drying.

Step 6 – Post-drying heat step: Heat the dried product in a 275°F oven for 10 minutes. This heating has the potential to reduce *Salmonella* levels by approximately 2 logs from the level of reduction achieved during initial heat step (Harrison et al., 2001). This step may be needed for processes that do not result in an adequate reduction of *Salmonella* through the heating process.

Step 7 - Handling: The establishment's Sanitation SOPs (9 CFR 416) should ensure that product is properly handled to prevent re-contamination or cross-contamination of the meat and poultry products by the bacterial pathogens of concern.

Validating Custom Processes

Establishments, or their processing authorities, may develop customized processes that that achieve an appropriate reduction of pathogens throughout the product. Customized processes should be based on a scientific rationale, supported by experimental data. They may be developed by using information obtained from the literature, from unpublished studies that are scientifically valid, or by comparing the methods used by the establishment with established procedures that have been validated to achieve the required $\log_{10}$ reduction of the pathogen. At a minimum, a validation study for a microbiological food safety hazard should identify the hazard, indicate the $\log_{10}$ reduction achieved for the specified pathogen, describe how the $\log_{10}$ reduction of the pathogen was achieved or determined, specify the actual processing conditions (e.g., time, temperature, and humidity), list critical ingredients (e.g., salt, sugar, and cure), and list the critical product characteristics (e.g., pH, water activity, and fat content). The processing procedures, ingredients, and product characteristics may determine the range of products to which the study applies. For example, if the test product contains additives that increase the heat resistance of *Salmonella*, the process could apply to all products that did or did not include the additives since a worst case formulation was used in the study. On the other hand, an additive may have a bactericidal effect and thus limit the products to those that contain the additive. Alternative or custom processes must be validated (9 CFR 417.4).

Challenge studies are excellent means to validate processes. Validation by a challenge study is based on scientific rationale and provides the necessary data to determine the $\log_{10}$ reduction of the target pathogen. Pathogen challenge studies should be conducted in a testing laboratory and not in the processing plant environment. Product sampling results, based on historical data alone, should not be used to validate these procedures because they do not provide information on the incoming pathogen load and, consequently, the level of pathogen reduction achieved is unknown.

Definitions

Lethality treatment. A process, including the application of an antimicrobial agent, that eliminates, or reduces the number of, pathogenic microorganisms on or in a product to make the product safe for human consumption. Examples of lethality treatments are cooking or the application of an antimicrobial agent or process that eliminates or reduces pathogenic microorganisms. (9 CFR Part 430.1).

References

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